Detector characterisation for the investigation of micro-bunch instabilities at Diamond Light Source.

Aiveen Finn

JAI Octoberfest 2014 at RHUL

Micro-bunch instabilities (MBI)

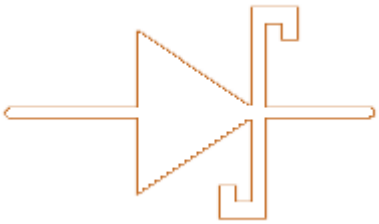
1. Threshold current exceeded
2. Bunch filaments quasi-periodically
3. Emit CSR in mm range
4. $\lambda_{CSR} < \sigma_z$

Aims

1. Measure the spectral characteristics of the radiation generated via the micro-bunched beam in a turn by turn regime.

2. Develop a single shot spectrometer.

3. Characterise detectors for the spectrometer.



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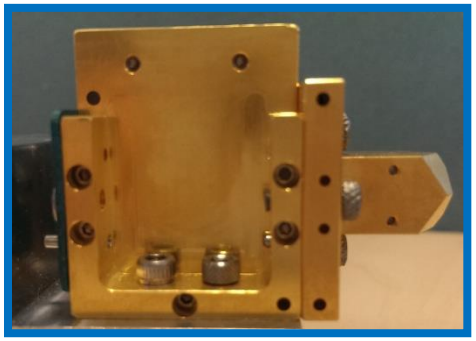
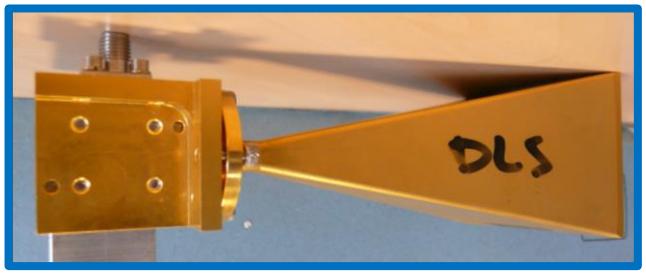
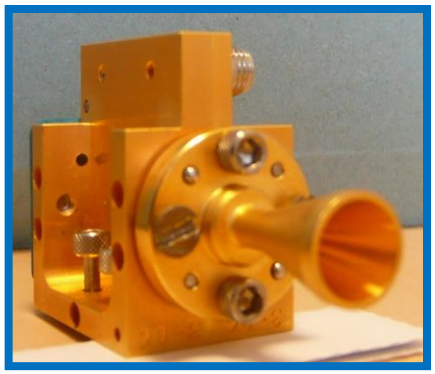
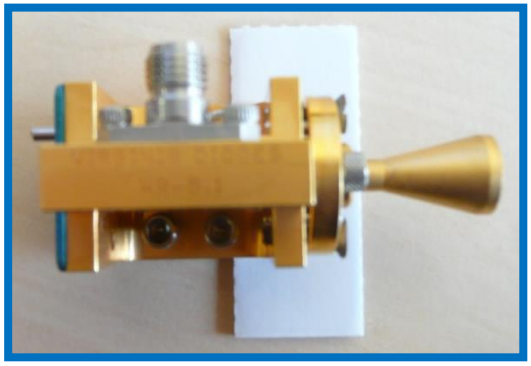
Detectors









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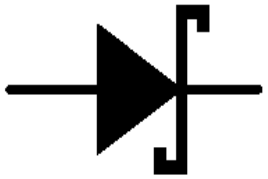
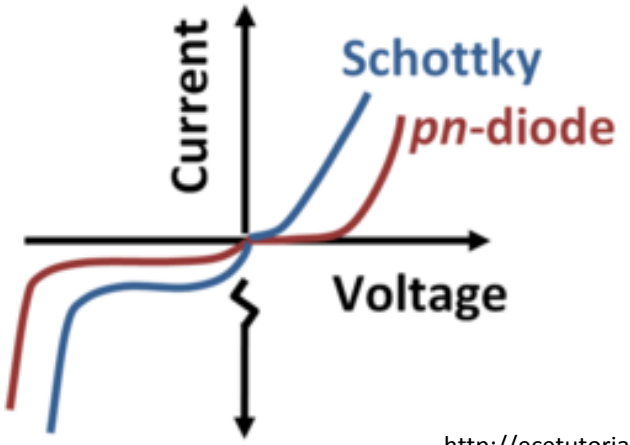


Why Schottky Detectors?

- Ultra-fast
- Excellent sensitivity
- Low noise
- Room temperature



http://ecetutorials.com

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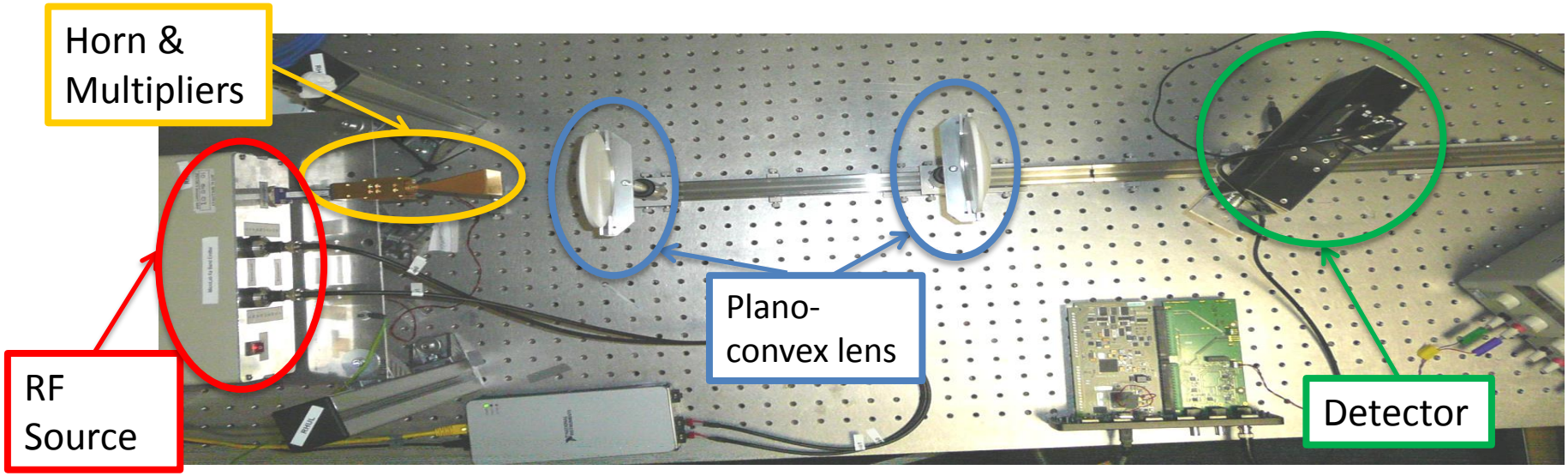

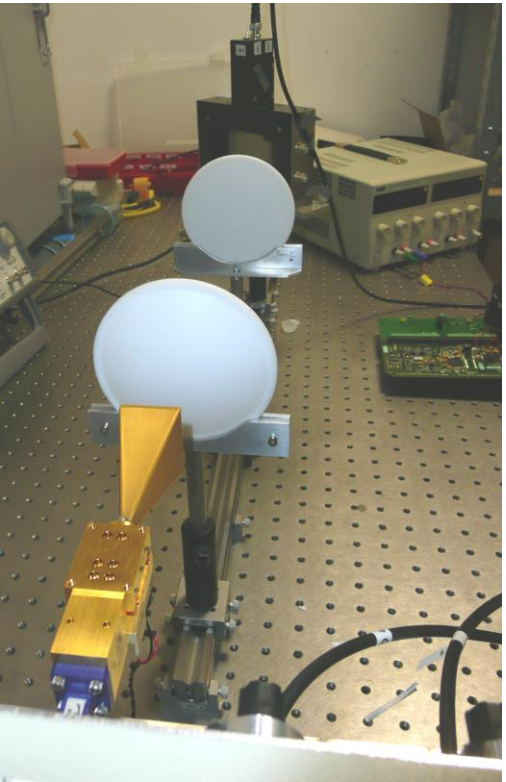

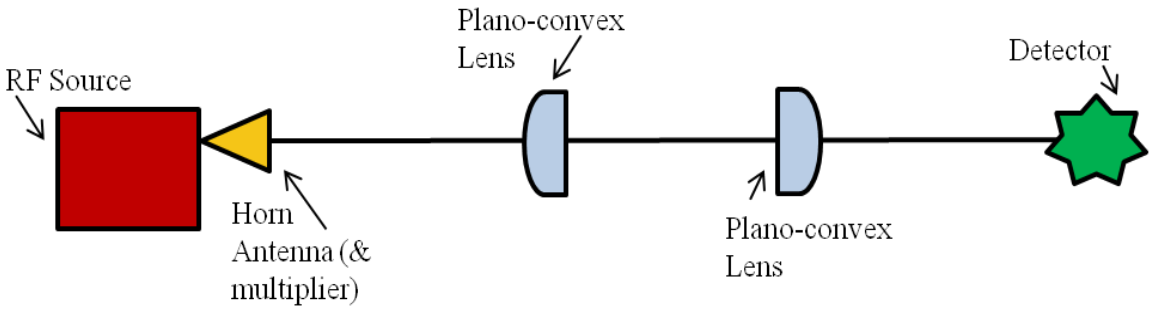

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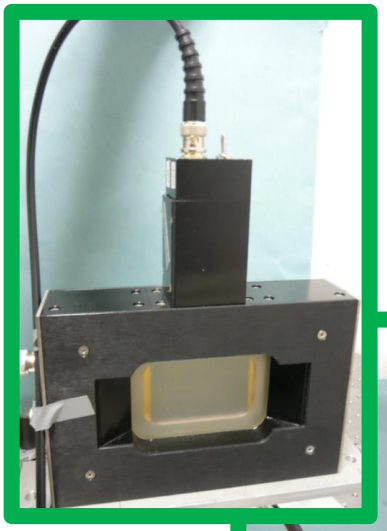
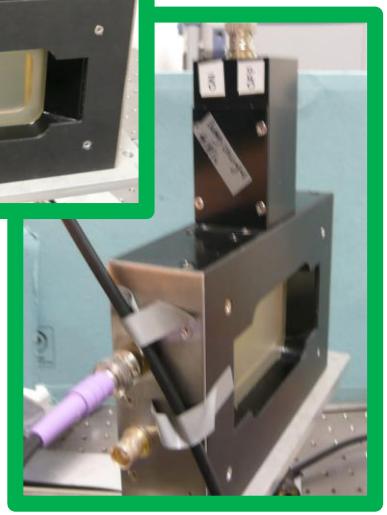
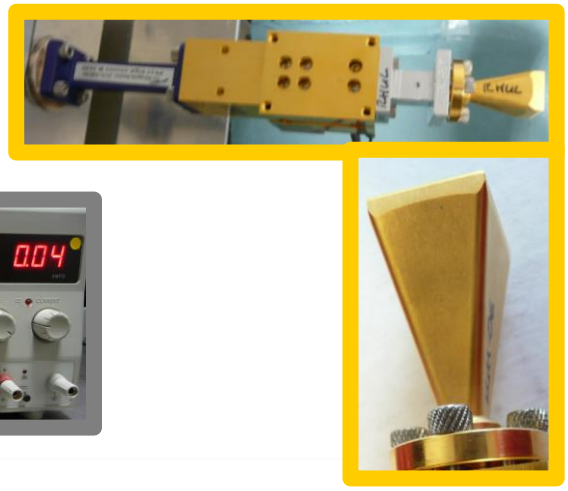
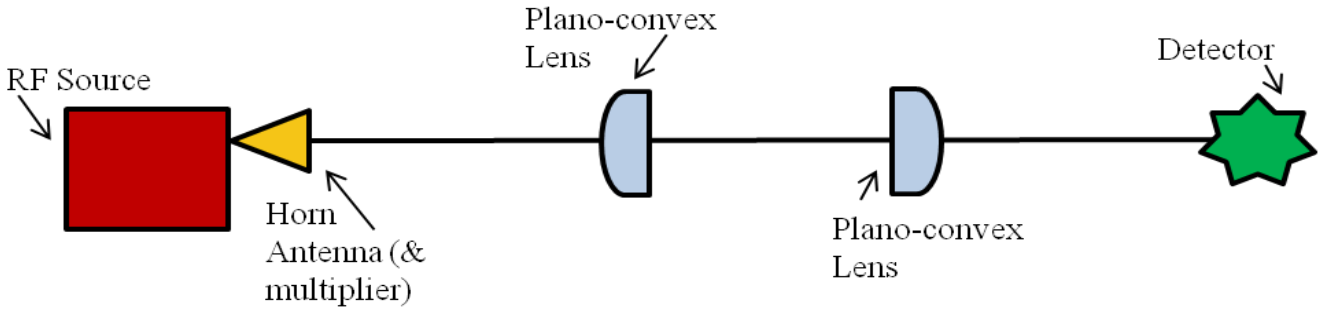
Power
FREQUENCY
Internal
External
ATTENUATOR
RF output






05.0
00.0
03.5
00.4




RF Source
Horn
Antenna (&
multiplier)
Plano-convex
Lens
Plano-convex
Lens
Detector

RF Source

- Ka band emitter
- **26.5 – 40 GHz** → 240 GHz
- Voltage controlled oscillator (Gunn diode)
- Frequency & attenuation controlled via BNC contacts or dials

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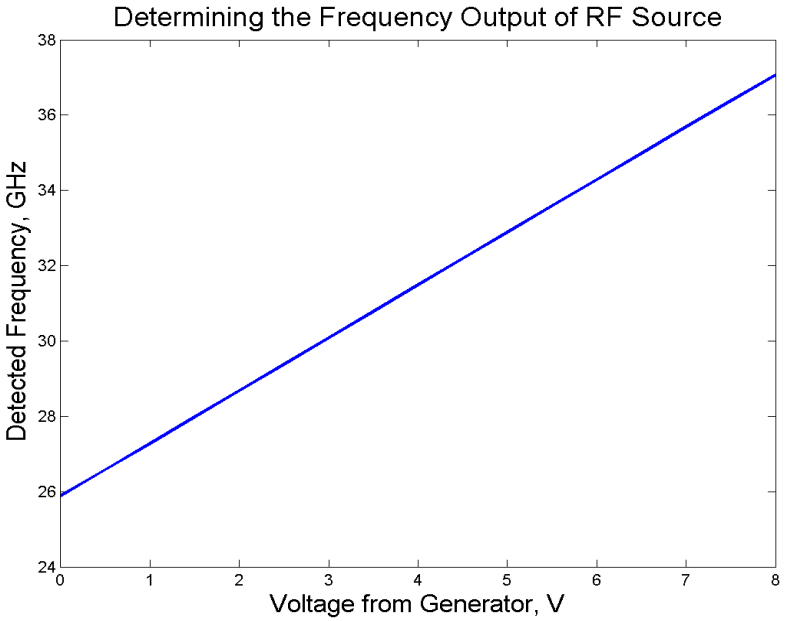
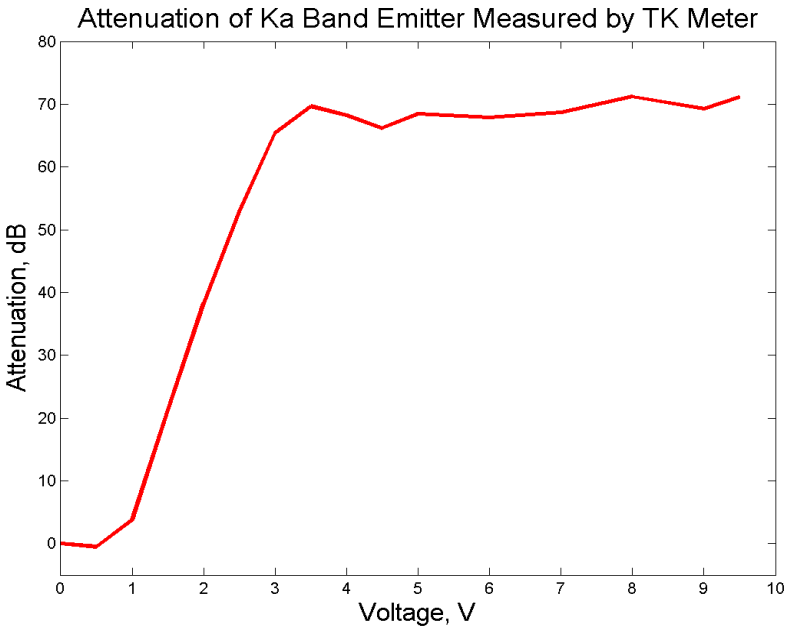
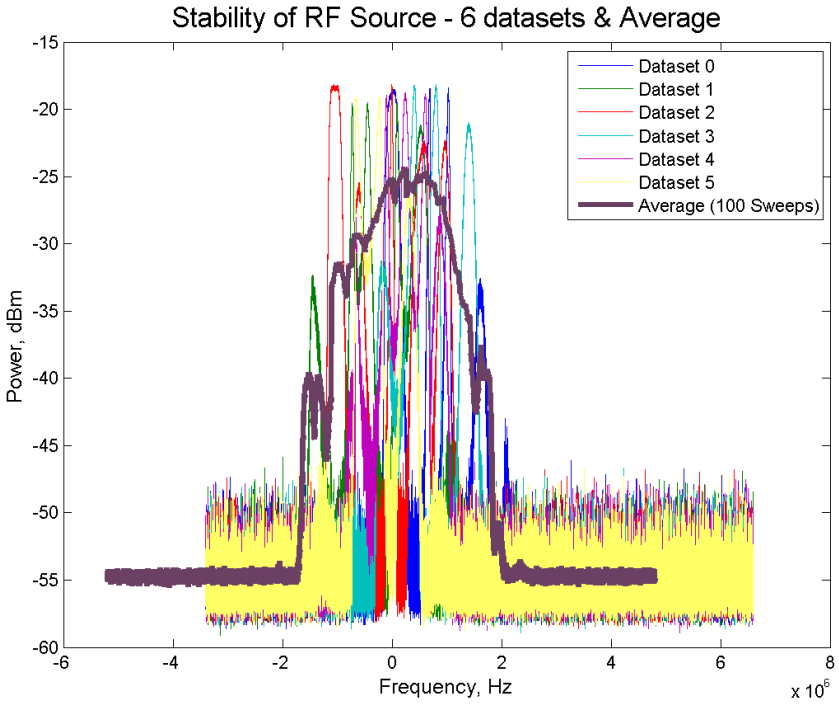
Ouantification of RF Source







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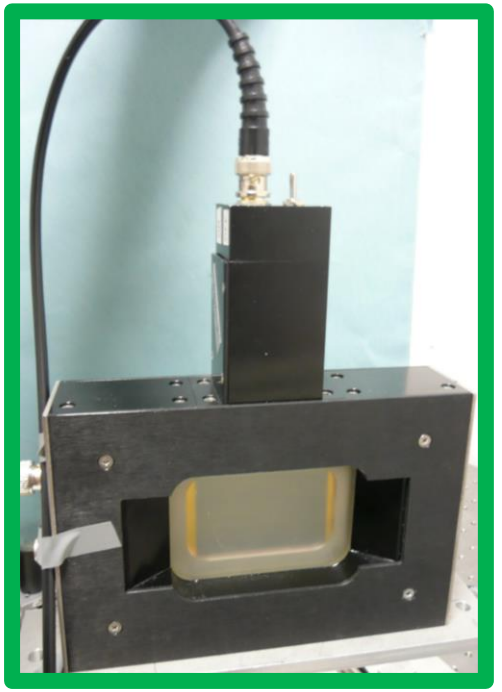
TK Head



- Thomas Keating Power Meter
- Broadband
- ‘gold standard’
- All detectors to be compared against it

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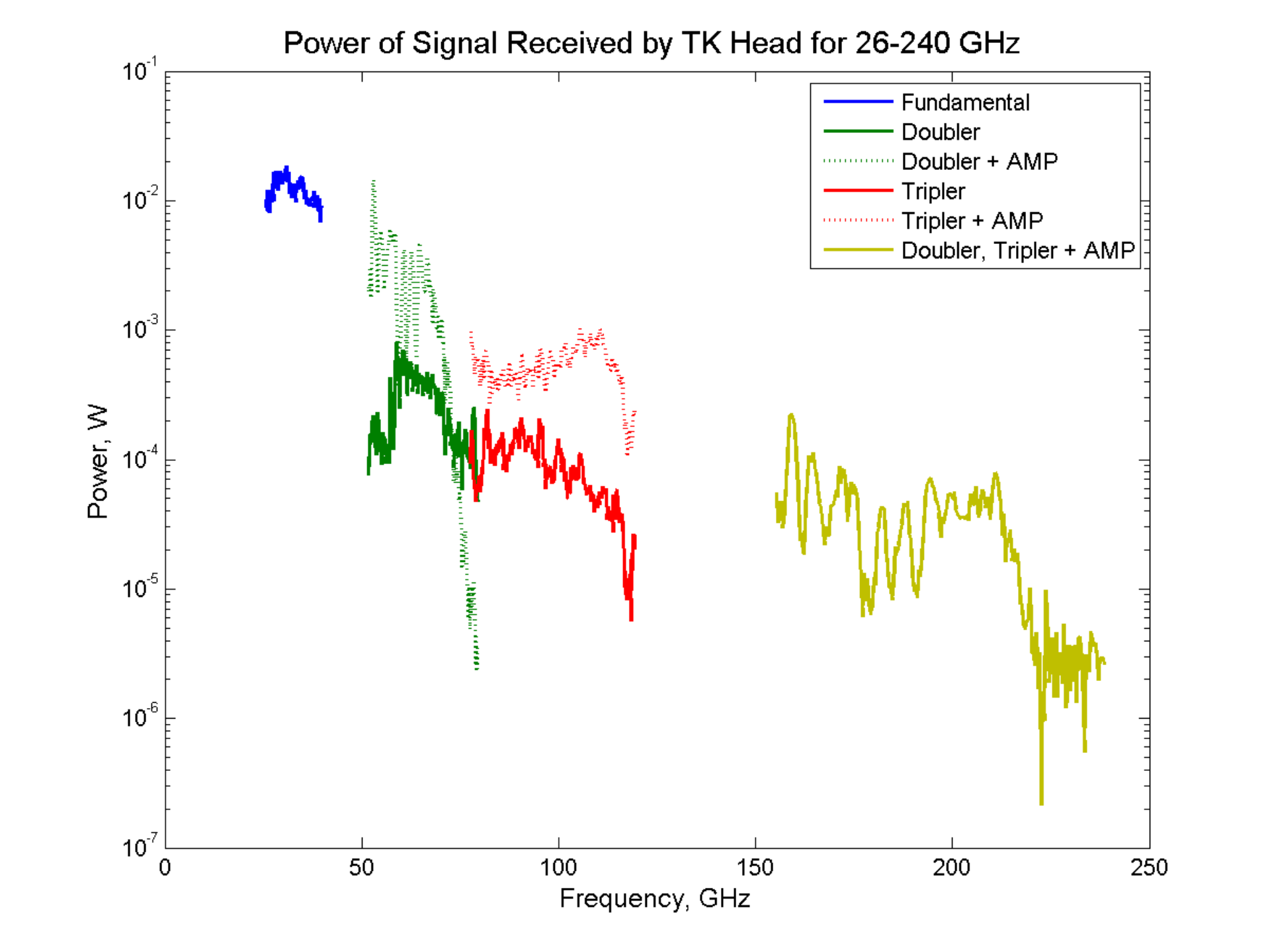
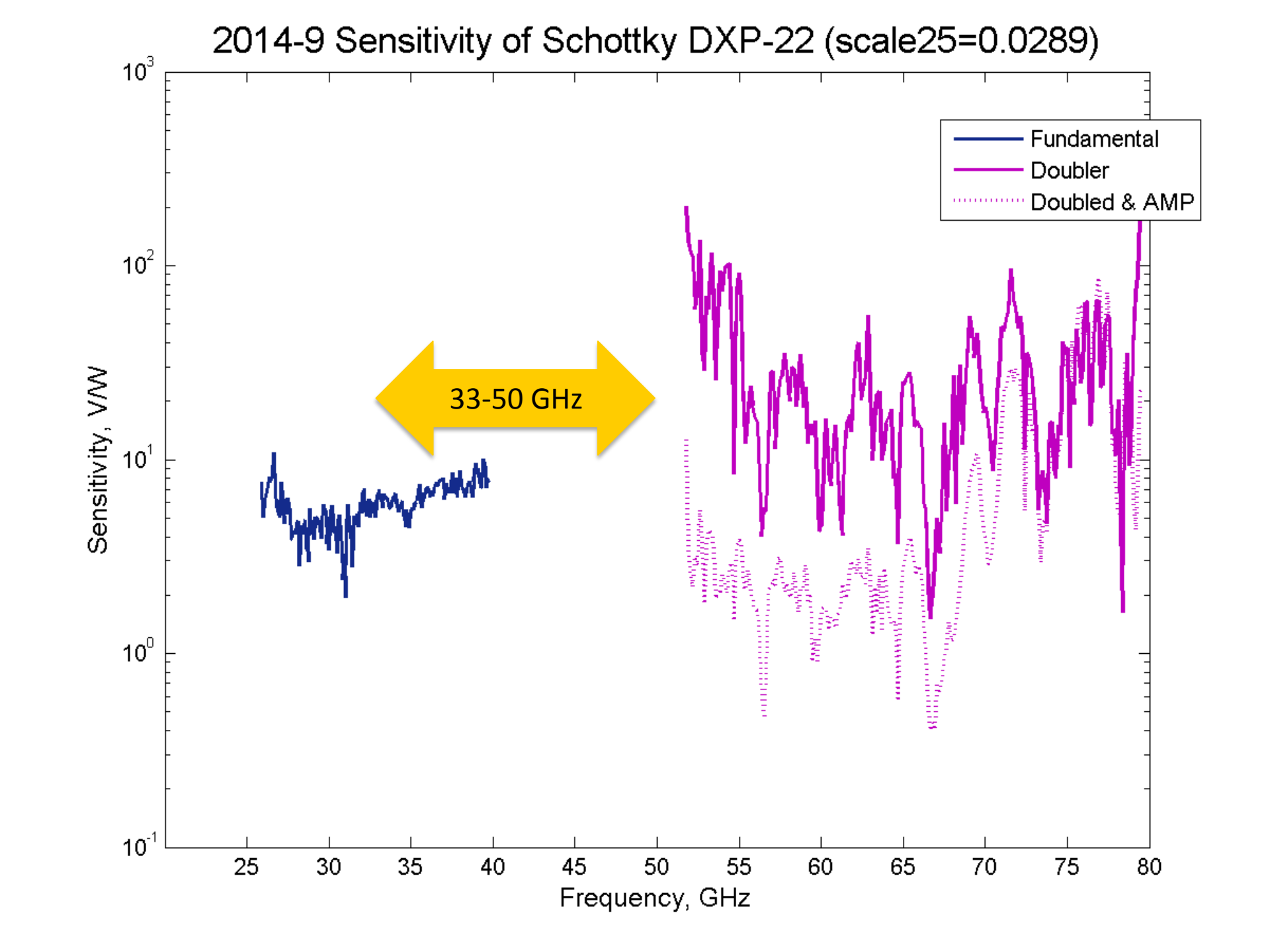
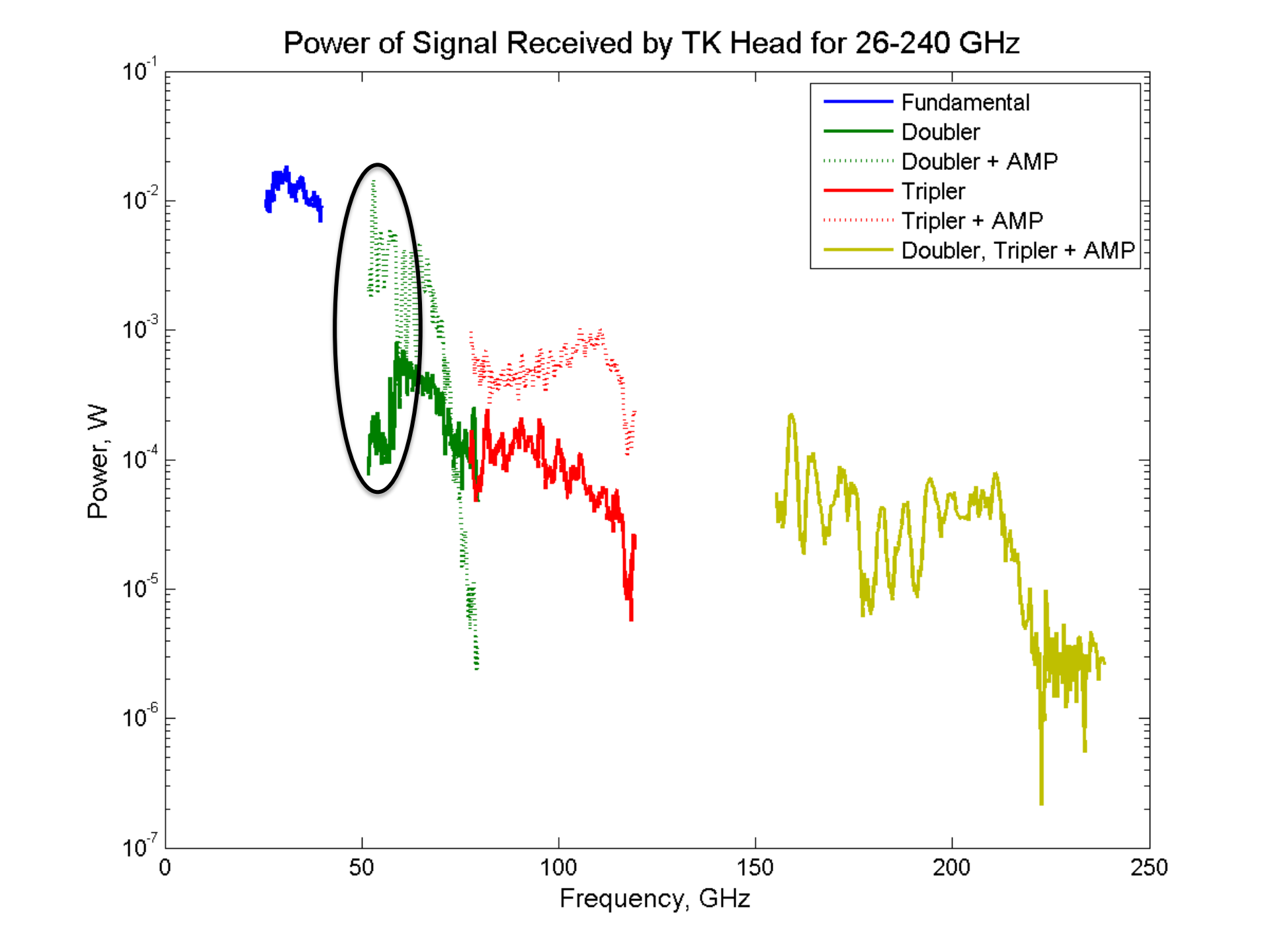
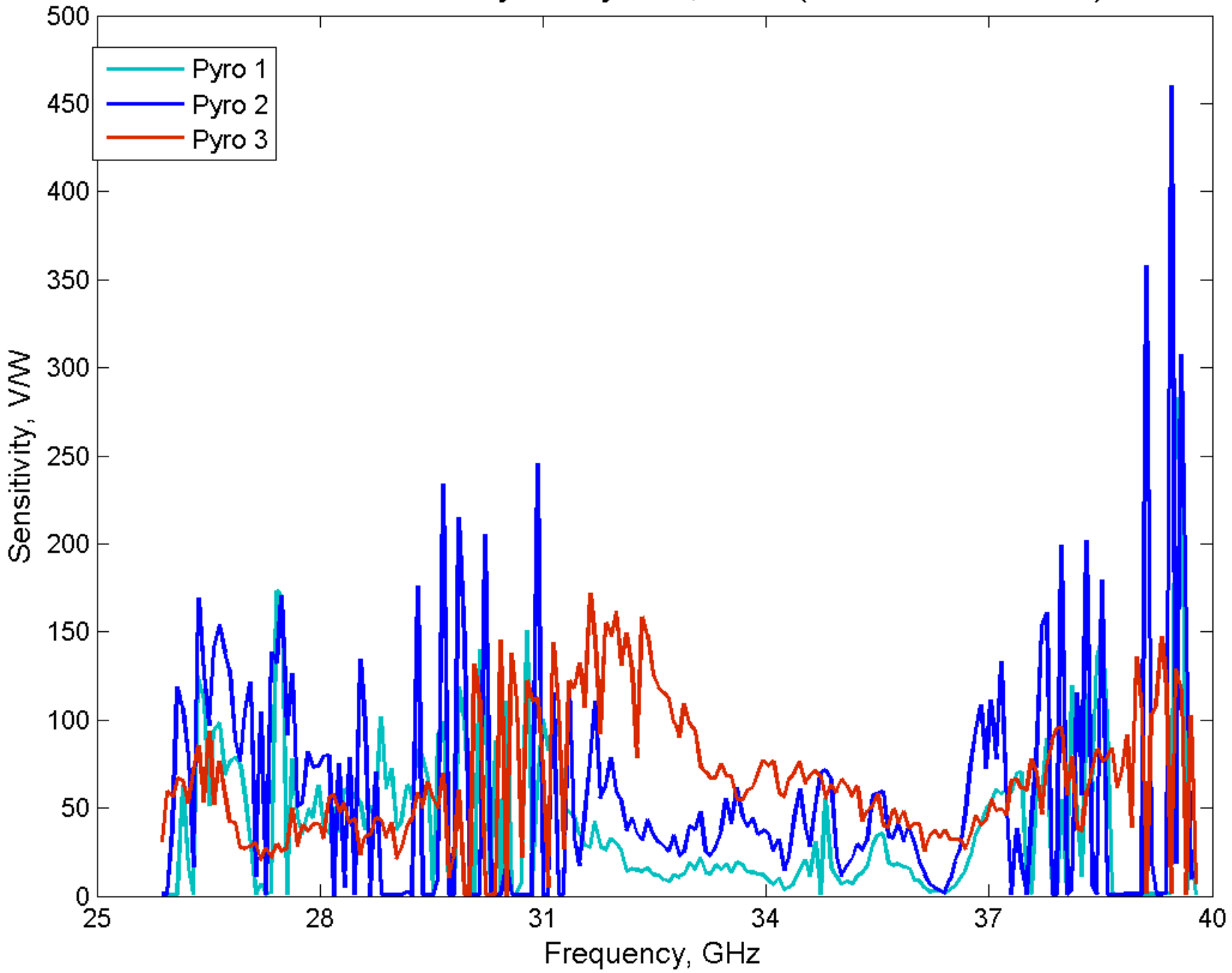

Power of Signal Received by TK Head for 26-240 GHz
Fundamental
Doubler
Doubler + AMP
Tripler
Tripler + AMP
Doubler, Tripler + AMP
Power, W
Frequency, GHz
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
50
100
150
200
250


2014-9 Sensitivity of Schottky DXP-22 (scale25=0.0289)
Fundamental
Doubler
Doubled & AMP
33-50 GHz
Sensitivity, V/W
Frequency, GHz
10^3
10^2
10^1
10^0
10^-1
25
30
35
40
45
50
55
60
65
70
75
80


Power of Signal Received by TK Head for 26-240 GHz
Fundamental
Doubler
Doubler + AMP
Tripler
Tripler + AMP
Doubler, Tripler + AMP
Power, W
Frequency, GHz
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
50
100
150
200
250


2014-9 Sensitivity of Pyro 1,2 &3 (scale25=0.0289)
Pyro 1
Pyro 2
Pyro 3
Sensitivity, V/W
Frequency, GHz
0
50
100
150
200
250
300
350
400
450
500
25
28
31
34
37
40

Further Work

- Investigate difference between doubler & amplified doubler.
- Determine sensitivities for the detectors.
- Continue to design the spectrometer.

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Thank you

With thanks to P. Karataev, G. Rehm, W. Shields and the Diagnostics Group at Diamond.

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Frequency → Wavelength

- υ = 3 GHz → λ = 100 mm = 10 cm
- υ = 30 GHz → λ = 10 mm = 1 cm
- υ = 300 GHz → λ = 1 mm
- υ = 3000 GHz → λ = 0.1 mm

- υ = 26.5 GHz → λ = 11.3 mm
- υ = 40 GHz → λ = 7.5 mm
- υ = 52 GHz → λ = 5.8 mm
- υ = 75 GHz → λ = 4 mm
- υ = 120 GHz → λ = 2.5 mm
- υ = 240 GHz → λ = 1.3 mm

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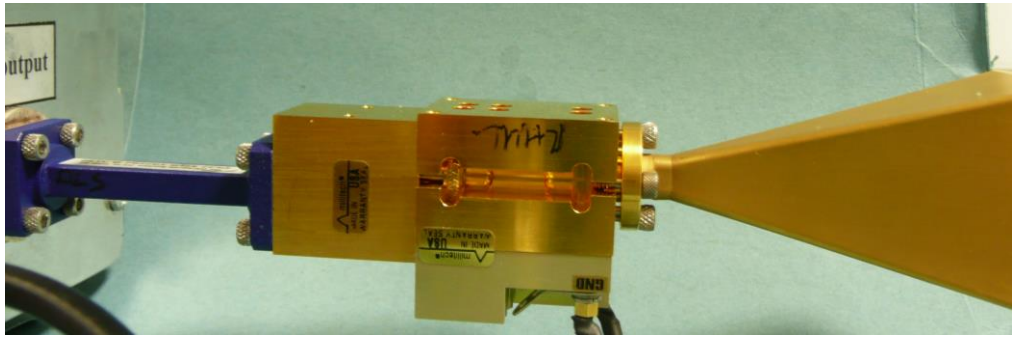
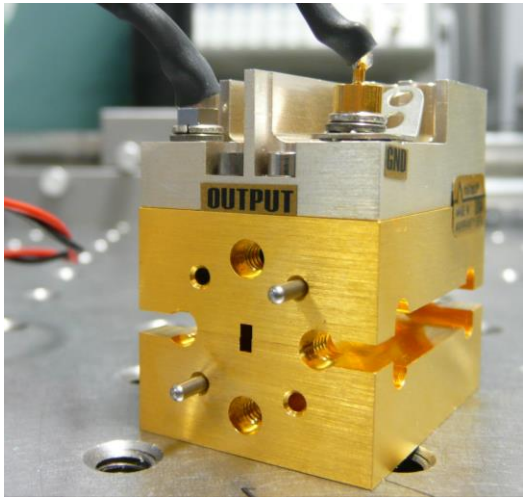
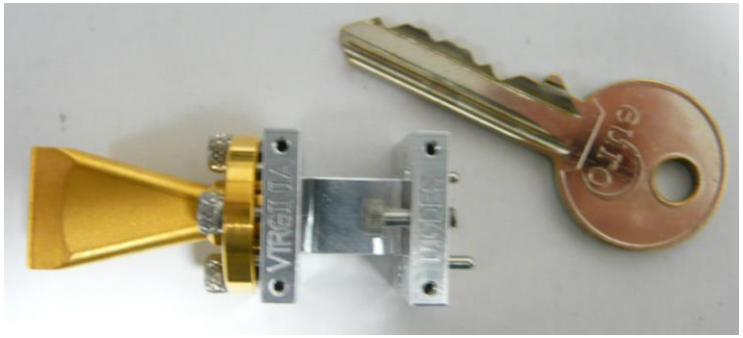
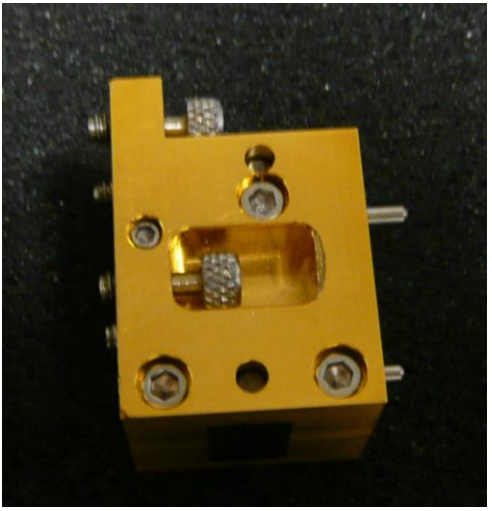
Multipliers & Amplifiers









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